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Carnivorous habits of two species of the genus *Craspedochiton* (Polyplacophora: Acanthochitonidae)

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ABSTRACT

Skeletal ossicles of brittle stars were found in gut contents of *Craspedochiton* sp. and *C. pyramidalis*, both of which have an anteriorly expanded girdle. The results of morphological comparisons of these species with *Placiphorella*, which is known to be a carnivore with active trapping behaviour, suggest that these two *Craspedochiton* species have a similar active carnivorous habit which evolved independently.

INTRODUCTION

The genus *Craspedochiton* of the family Acanthochitonidae has a large anterior expansion of the girdle similar to that seen in the genus *Placiphorella* of the family Mopaliidae. McLean (1962) observed that *Placiphorella velata* (Carpenter MS) Dall, 1879 uses the expanded girdle to catch small, moving amphipods by abruptly clamping down the girdle, although they also feed in grazing manner like a typical chiton as well. Because of the similarity of structure of the girdle, we suspected that *Craspedochiton* has similar feeding habit to *Placiphorella*. However, except for a brief note by Watters (1991), no report on the feeding habit to *Craspedochiton* is available. The purpose of this study is to report on the feeding habits of *Craspedochiton* by morphological comparison with *Placiphorella* and by examination of gut contents.

MATERIALS

Living *Craspedochiton* were not observed. We examined the following preserved specimens, all of which were collected from Japanese waters:

Craspedochiton pyramidalis (Is. Taki, 1938) (Fig. 1A): Body length (BL) ca. 40 mm collected in water depth ca. 60 m, off Tomioka, Amakusa, Western Kyushu (in Amakusa Marine Biological Station, Kyushu University); BL ca. 26 and 21 mm, water depth unknown, off Ushibuka, Amakusa; BL ca. 18 and 17 mm, in water depth 90 m, Omurodashi Bank near Izu Oshima, Pacific side of central Honshu.

Craspedochiton sp. (Fig. 1B): BL ca. 24 mm, in water depth 30-40 m, off Ushibuka, Amakusa, Western Kyushu.

MORPHOLOGICAL COMPARISON

Expansion of the girdle is conspicuous when viewed from the ventral side in both *Craspedochiton* and *Placiphorella* (Fig. 2). In *Craspedochiton*, the ventral surface of the anterior area of the girdle is flat and covered with oval scales (Fig. 3A). In *Placiphorella* there are many papillae or vermicular processes with scattered spines

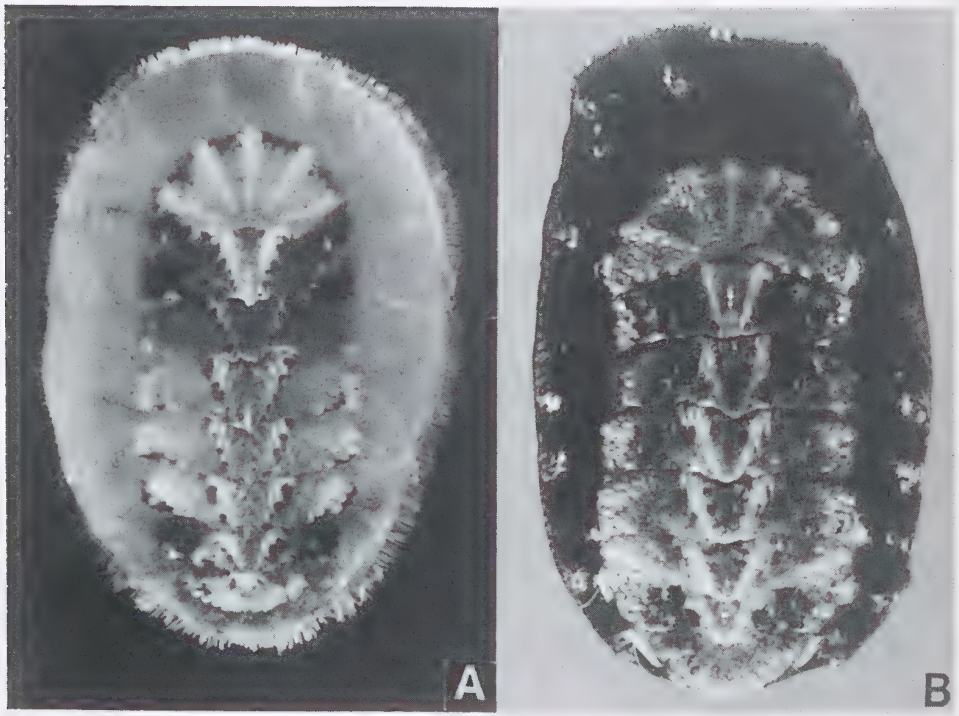

Figure 1. Dorsal view of animal. **A.** *Craspedochiton pyramidalis*, body length ca. 17 mm; **B.** *Craspedochiton* sp., body length ca. 24 mm.

(Fig. 3B). These spines vary in size and density among different species, being absent or extremely minute in *Placiphorella borealis* Pilsbry, 1893 (Saito & Okutani, 1989), and are long and tufted in *P. atlantica* (Verill & Smith, 1882) (Leloup, 1942). These papillae with spines or spinous tufts may help to immobilize the prey. No such papillae are found in *Craspedochiton*.

The ventral side of the girdle has conspicuous colour in both *Craspedochiton* and *Placiphorella*, unlike the usually whitish ventral side of most chitons. *Craspedochiton* has brownish maculations and *Placiphorella* has an orange or reddish cast. McLean (1962) stated that the colour of *Placiphorella* matches the reddish colour of coralline algae. Such a colour may work somehow when animal lifts up the girdle. The source of coloration varies between *Craspedochiton* and *Placiphorella*. In the former, it is due to the colour of scales or spicules, so that the colour is retained for a considerable period of in preserved specimens. In *Placiphorella*, reddish pigment present in the tissues fades soon after preservation.

Extensions of the anterior portion of the pallial fold are found in both *Craspedochiton* and *Placiphorella* (Fig. 2). The extension of *Craspedochiton* is so wide that mouth is often concealed under the fold when the specimen is preserved (Fig. 2A). There are many large leaflike scales around this area (Fig. 2A), which are distinctly larger than ordinary scales, and curve inwardly with many fine grooves on their surface (Fig. 3C). Their function has not been determined. In

Placiphorella, this portion of the pallial fold is extended when the animals lifts up the girdle, and is surrounded by fingerlike projections (or precephalic tentacles) (Fig. 2B) which are used in manipulation of prey (McLean, 1962).

The foot is considerably reduced in both *Craspedochiton* and *Placiphorella* (Fig. 2), suggesting they are sedentary animals. the 'homes' of sedentary *Placiphorella* are often hollowed. When *Craspedochiton pyramidalis* are removed from a coralline stone the underlying surface is whitish, suggesting this species is also sedentary.

A pronounced and common feature in the radula of *Craspedochiton* and *Placiphorella* is a small head of the major lateral tooth. The head is small in both length and width. Compared to *Acanthochitona rubrolineata* (Lischke, 1873) (Fig. 4C), the major lateral tooth of *Craspedochiton* is more similar to *Placiphorella* than *Acanthochitona*. This is the same in *Placiphorella* compared with *Mopalia seta* (Yakovleva, 1952) (Fig. 4D). Gut contents of *A. rubrolineata* are chiefly algae, but sometimes contain foraminiferans, ostracods, gastropods and sand grains, those of *M. seta* are foraminiferans, sponge spicules, algae and sand grains (Saito pers. obs.). *Mopalia hindsii* ((Sowerby MS) Reeve, 1847) has been known to feed on more animal materials (Barnawell, 1960). These *Acanthochitona* and *Mopalia* species feed to a greater or lesser extent on animals, however, they graze rather than trap the prey like *Placiphorella*.

Craspedochiton and *Placiphorella* both have large stomachs and simple posterior intestines compared with other acanthochitonids and mopaliids (Fig. 5).

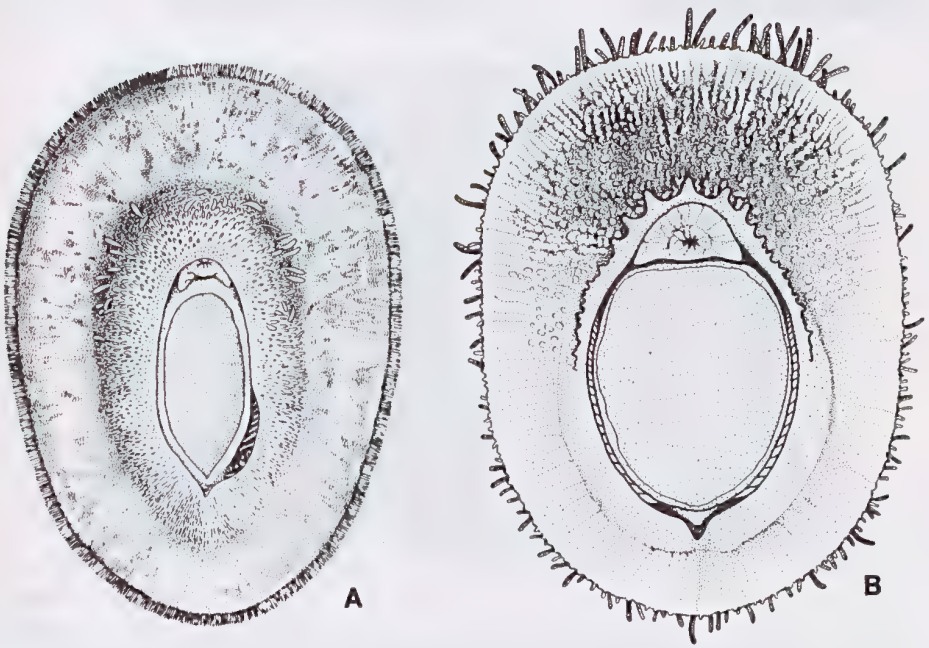

Figure 2. Ventral view of animal. **A.** *Craspedochiton pyramidalis*, body length ca. 17 mm; **B.** *Placiphorella stimpsoni*, body length ca. 40 mm.

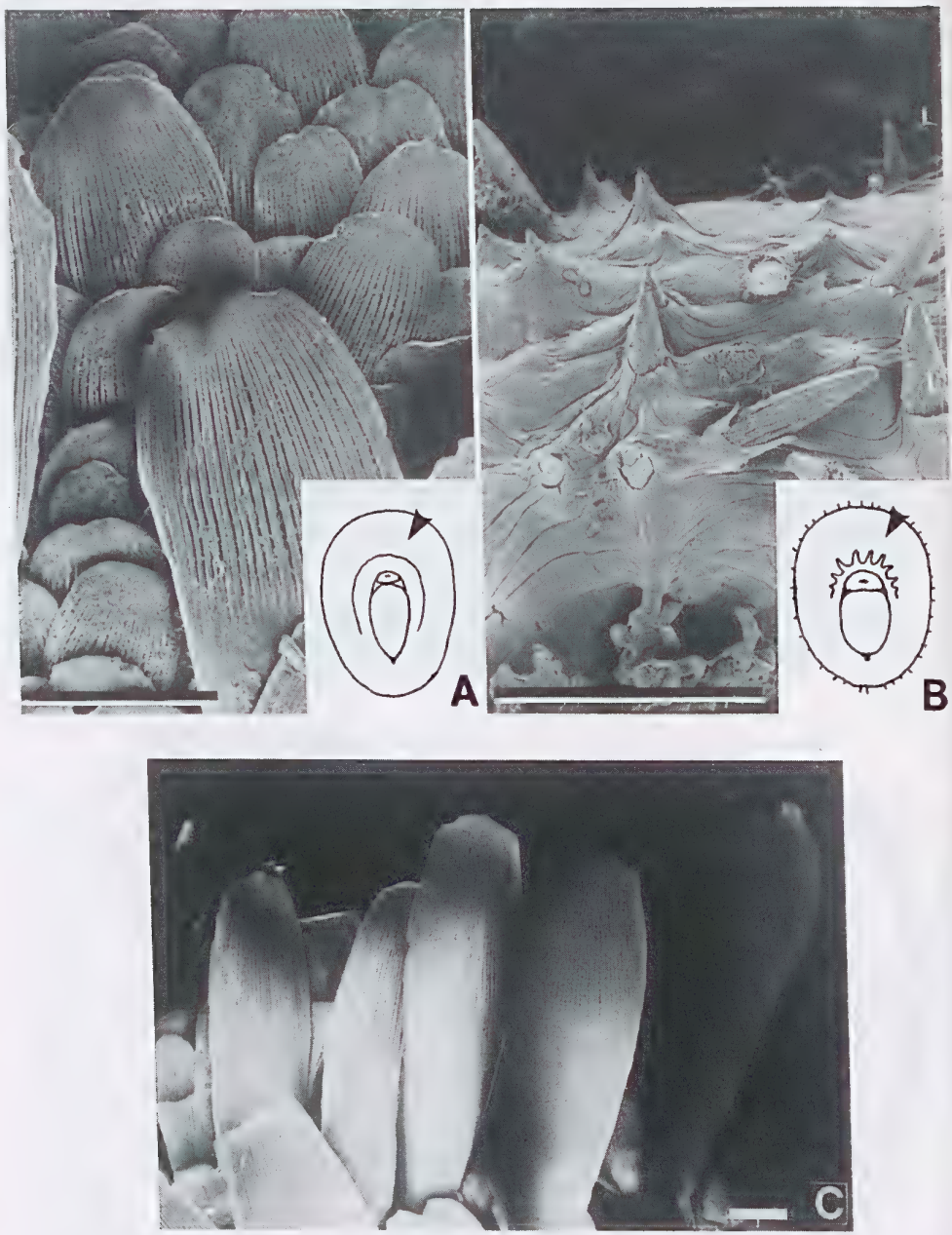

Figure 3. Ventral side of girdle. **A.** *Craspedochiton pyramidalis*, body length ca. 18 mm; **B.** *Placiphorella stimpsoni*, body length ca. 45 mm, surface on papilla; arrow in drawings indicates enlarged portion; **C.** leaflike scales of *Craspedochiton pyramidalis*, body length ca. 18 mm; scale lines: 100 μm.

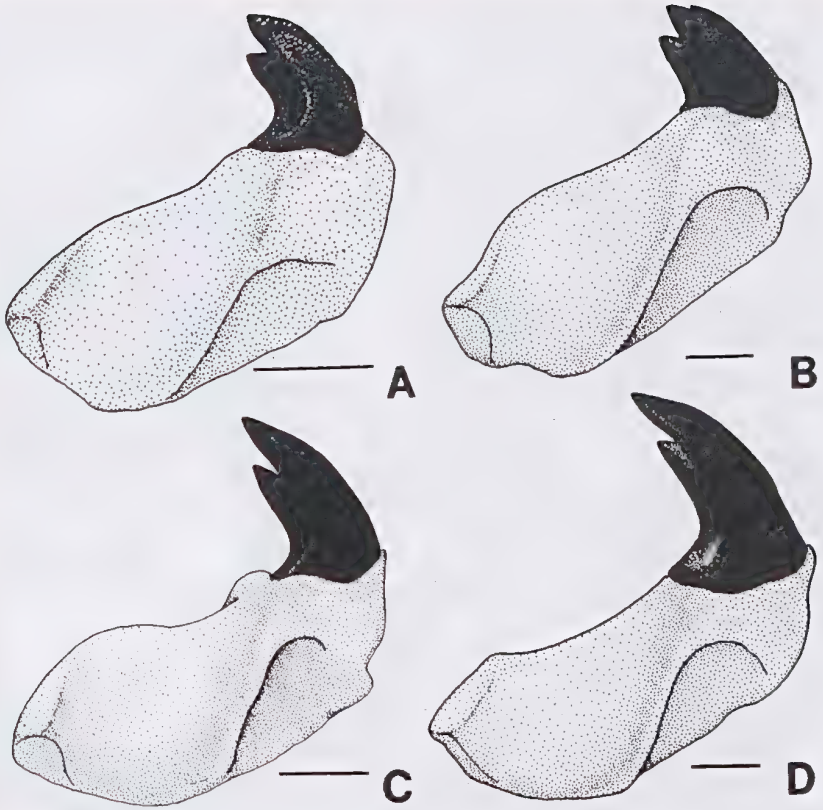

Figure 4. Major lateral tooth, lateral view. **A.** *Craspedochiton pyramidalis*, body length ca. 40 mm; **B.** *Placiphorella stimpsoni*, body length ca. 45 mm; **C.** *Acanthochitona rubrolineata*, body length ca. 25 mm; **D.** *Mopalia seta*, body length ca. 37 mm; scale lines: 100 μm.

The stomach of *Craspedochiton* is smaller than that of *Placiphorella*, the stomach is voluminous and has no ventral constriction (Fig. 5B). The deep constriction of *Craspedochiton* may increase its stomach capacity.

OBSERVATION OF GUT CONTENTS

***Craspedochiton pyramidalis*:**

1. BL 40 mm - Skeletal ossicles of a brittlestar of the genus *Ophiothrix*, probably *O. (Ophiothrix) panchyendyta* H.L. Clark, were present in gut contents. The ossicles comprise fragments of the disk and arms, suggesting that the chiton ingested an entire brittlestar estimated from the length of radial shield (Fig. 6A) to have a disk diameter of 6-7 mm.

2. BL 26 mm - Claws or chelipeds and other fragments of the exoskeleton of an unidentified decapod (Fig. 6B).

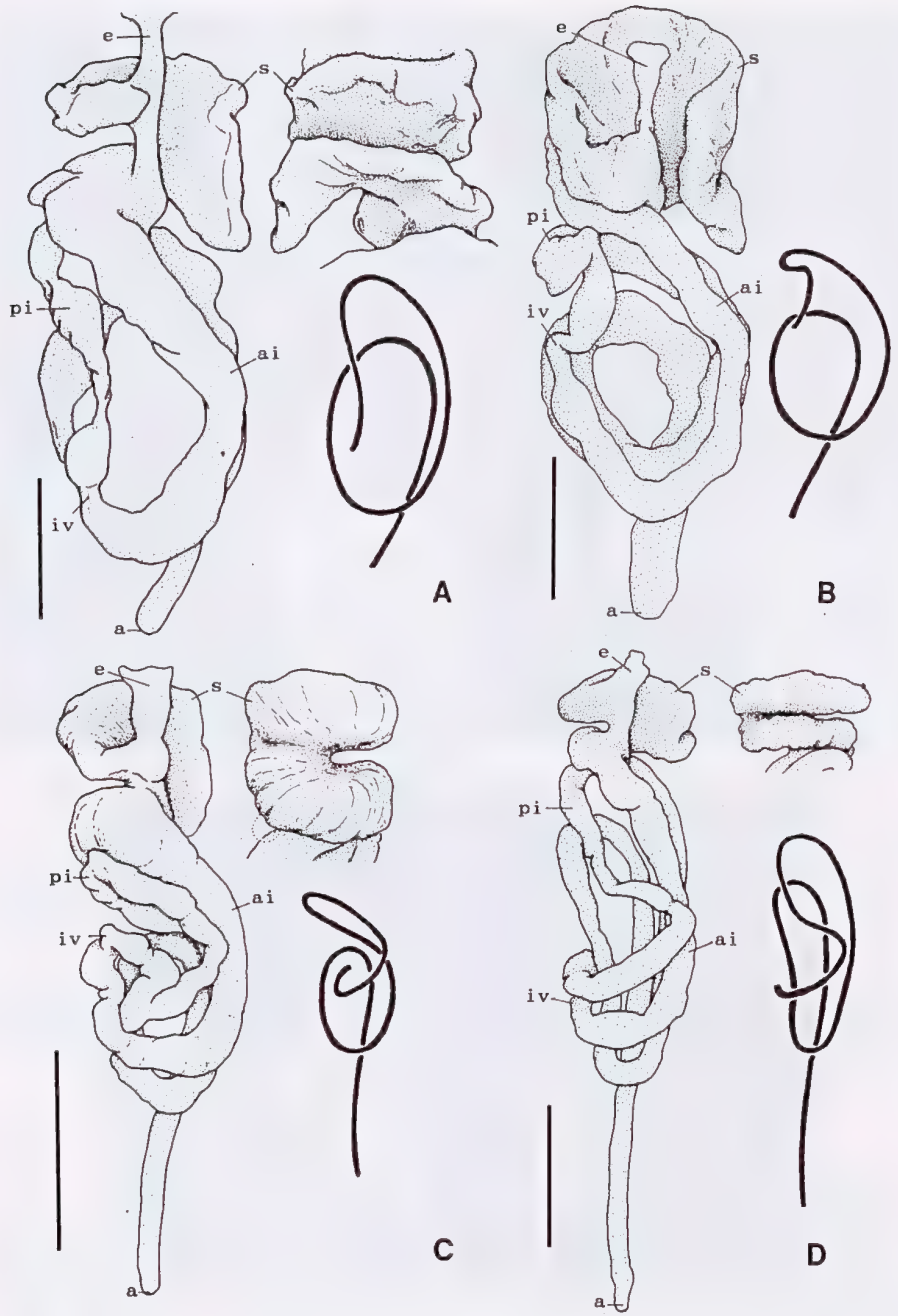

Figure 5. Alimentary canal, dorsal view, ventral view of stomach and pathway of posterior intestine. **A.** *Craspedochiton pyramidalis*, body length ca. 40 mm; **B.** *Placiphorella stimpsoni*, body length ca. 45 mm; **C.** *Acanthochitona rubrolineata*, body length ca. 25 mm; **D.** *Mopalia schrencki*, body length ca. 31 mm; scale lines: 5 mm.

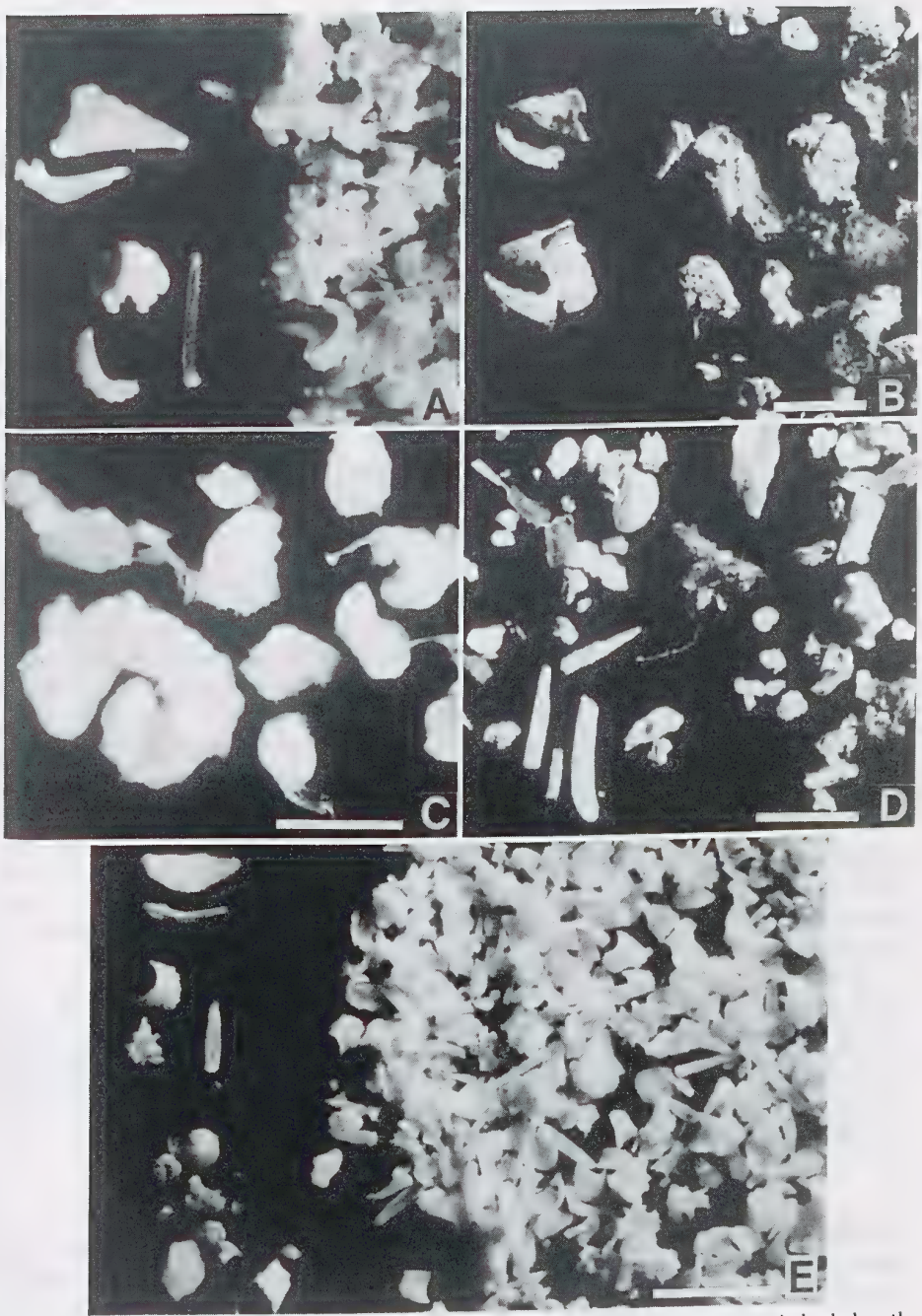

Figure 6. Gut contents. **A-D.** *Craspedochiton pyramidalis*, **E.** *Craspedochiton* sp. **A**; body length 40 mm, skeletal ossicles of a brittle star; **B.** body length ca. 26 mm, exoskeleton of an unidentified decapod; **C.** body length ca. 18 mm, fragments of annelids; **D.** body length ca. 21 mm, sessile animals and sand grains; **E.** body length ca. 24 mm, skeletal ossicles of a brittle star; scale lines: 1 mm.

3. BL 18 mm - Fragments of annelids (Fig. 6B).

4. BL 21 mm - Foraminiferans, pieces of coral skeleton, bryozoans, sand grains and other unidentified particles (Fig. 6D).

***Craspedochiton* sp.:**

BL 24 mm - The stomach contents included skeletal ossicles of a brittle star of the genus *Ophiogymna*, probably *O. elegans* Ljungman or *O. fulgens* Koehler, foraminiferans and sand grains. Like the previous example, both the disk and arms of a brittle star were found (Fig. 6E).

DISCUSSION

Two modes of feeding, that is, trapping and grazing have been known in *Placiphorella* (McLean, 1962). Analysis of gut contents suggests that *Craspedochiton* is also both a carnivorous and grazing species. *Craspedochiton* has not been observed catching mobile prey, but gut contents and several morphological characters in common with *Placiphorella* suggest that *Craspedochiton* also clamps down on the girdle to hold down prey. The extension of the anterior portion of the pallial fold and the expansion of the girdle are the most important characters supporting this inference. McLean (1962) observed in *Placiphorella* that the pallial fold is extended when animal lifts the girdle. The extended pallial fold of *Craspedochiton* may be used in the same way. Several structures in addition to the pallial fold, such as the small foot, small head of major lateral radular tooth, large stomach and simple intestine, are all common features between *Craspedochiton* and *Placiphorella*.

Another example of active trapping behaviour in chitons was reported by Ludbrook and Gowlett-Holmes (1989) in *Loricella angasi* (H. Adams in H. Adams and Angas, 1864) of the family Schizochitonidae. They reported that *L. angasi* feeds mainly on amphipods by rapidly clamping down the girdle. The girdle of *L. angasi* is also enlarged like those of *Craspedochiton* and *Placiphorella*. Moreover, similar specializations, that is, fringes around the mouth and a small foot were found on the ventral side of *Loricella*. The fact that the mouth is distinctly separated from the foot may be related to ingesting a trapped animal.

These three distinct genera, namely, *Craspedochiton*, *Loricella* and *Placiphorella*, all have morphological characters that are related to similar feeding habits. When the characters were compared in detail, however, they were found to be rather different devices used for the same purpose. Therefore, this feeding is regarded as in independent acquisition in their lineages, rather than an inherited character from a common ancestor.

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